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Coal In Nebraska

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COAL IN NEBRASKA

By ROY V. PEPPERBERG

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Until February, 1906, Nebraska was termed "the state without a mine," and may still be called the state with but a single mine, and yet it would be impossible to tell how much prospecting has been done, or to estimate the number of thousands of dollars that have been spent in this state trying to develop paying mines from the thin beds of coal discovered throughout various parts of the state in the Carboniferous and Cretaceous formations.

The Cretaceous is a coal producing system in general, especially in Colorado and Wyoming, and its members have played an important part in the history of coal prospecting in this state.

The purpose of this paper is to discuss the occurrence of coal in Nebraska in the different formations, which outcrop throughout the state, giving particular reference to the bed which is now being worked at Peru, Nebraska.

A section of the rocks of Nebraska from east to west across the state may be seen in Fig. 1.

Pennsylvanian Formation.

The formation outcrops along the Missouri River from a point north of Omaha to the southeast corner of the state, along the Platte River from Plattsmouth west to Ashland, and in the counties south of these points. They make up the surface or bed rock in all of Richardson and Nemaha counties, nearly all of Johnson, Pawnee, and Otoe, and parts of

Editorial Note:

After completing his study, and after passing the examination required for his Masters Degree, the writer of this paper submitted the following two-part thesis:

1. Coal in Nebraska (the present paper).
2. A preliminary report on the Carboniferous Flora of Nebraska (to be published in a succeeding part.)

Cass, Sarpy, Douglass, Washington, Lancaster and Gage counties (See Fig. 3.) This series shows fifteen shale seams with thick beds of limestone in the upper part of the section. All of these carry some coal but the amount in the upper members is so slight that they should really not be called coal-bearing for the coal is not present in nearly as large quantities as in some formations of other systems. These are the only members of the coal-measures that occur in Nebraska and confirm us in the belief that Hayden was right when he said, fifty years ago that, "Nebraska lies on the western border of the coal basin and however deep borings may be carried along the Missouri River no seams of coal over two or two and one-half feet will ever be penetrated." This statement with one exception holds good today and expresses the opinion of geologists in general.

FORMATIONS IN NEBRASKA.

Quaternary	(20)	Alluvium.	
	(19)	Dune sand.	
	(18)	Loess—0 to 100 feet.	
	(17)	Drift.	
	(16)	Equus beds.	
Tertiary.	(15)	Ogalalla—Pliocene	Loup Fork beds
	(14)	Arikaree—400 to 500 feet, Miocene.	Loup Fork beds
	(13)	Gering—100 to 200 feet.	
	(12)	Brule—200 to 300 feet.	Oligocene Bad Lands.
	(11)	Chadron—100 feet.	Oligocene Bad Lands.
Cretaceous.	(10)	Laramie (?)	
	(9)	Pierre—0 to 1,000 feet or more.	
	(8)	Niobrara—200 to 400 feet.	
	(7)	Carlisle—100 to 500 feet.	Benton group.
	(6)	Greenhorn—20 to 30 feet.	Benton group.
	(5)	Graneros—50 to 900 feet. (?)	Benton group.
	(4)	Dakota—300 to 400 feet.	
	(3)	Morrison (?)	
Carboniferous	(2)	Permo-carboniferous 200 to 300 feet.	
	(1)	Pennsylvanian coal-bearing, 1,000 to 1,200 feet.	

Hayden also observed, that "the beds of eastern Nebraska pass under the state and appear in the Black Hills and Mountains and there again show no indications of coal of any thickness."

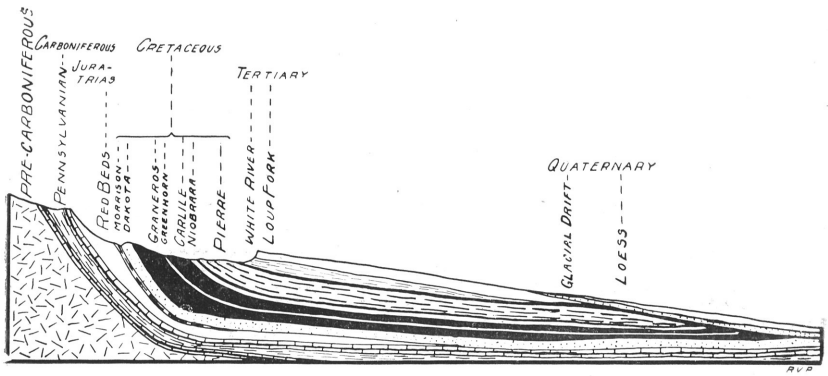

Fig. 1. A geological section from the Missouri River to the Black Hills. Modified after Darton.

The presence of thin seams of coal in the southern part of the state has been observed since the time of earliest settlement, and many farmers in this section have dug enough coal from their farms to supply their domestic needs. This is however the extent of the production and most of these small mines were soon abandoned as unprofitable.

The following coal analyses were made by the Department of Chemistry, The University of Nebraska, and were run partly or entirely air-dry. No. 1 is from Nemaha County, No. 2 from Cass County, No. 3 from Otoe County, and No. 4 from Richardson County:

No.	Moisture	Vol. Comb. Matter	Fixed Carbon	Ash	Sulphur
1	4.46	36.67	45.26	9.50	4.09
2	13.23	44.56	32.04	10.21	....
3	7.10	20.52	29.10	36.46	6.81
4	7.87	31.52	50.36	10.26	....

COAL EXCITEMENTS.

The following account of a coal excitement was reported by Meek and Hayden as early as 1867 and records what was probably one of the first in this portion of Nebraska:[1]

"At Tecumseh a thin bed of coal has been opened, and is now worked with some success by Mr. Beatty. The drift is very similar to that before described in my report of Pawnee County, and extends into the bank about one hundred yards. Mr. Beatty has taken out about a thousand bushels of coal, which he sells readily at the mine for twenty-five cents per bushel. It is undoubtedly the same bed that is opened at Turner's Branch and at Frieze's Mill, in Pawnee County, but is not quite as thick or as good; it contains large masses of sulphuret of iron and other impurities. The coal seam here varies much in thickness, from ten to fifteen inches. The cap rock is a bed of limestone not more than two or three feet in thickness.

A well was sunk in the village of Tecumseh sixty feet; a drill was driven down through the rock and hard clay a few feet farther, and passed through what the workmen thought to be three feet of good coal. This discovery created much excitement at the time, and increased the demand for public lands in Johnson County. It afterwards turned out to be the same seam of coal worked by Mr. Beatty on the Nemaha, and was only eleven inches in thickness. The prospects, therefore, for workable beds of coal in Johnson County are no better than in neighboring counties already examined."

A year seldom passes without reports of the discovery of a "workable bed of coal" in southeastern Nebraska, and the organization of a company to promote the development of the same. Funds are raised and drilling operations begun, or a shaft is sunk, and in each of hundreds of cases the result is the same, money thrown away in the fruitless search for coal. In many cases the State Geologist is asked for his unbiased opinion as to the probability of the presence of coal

1. U. S. G. S. of Nebraska by Meek and Hayden, p. 34.

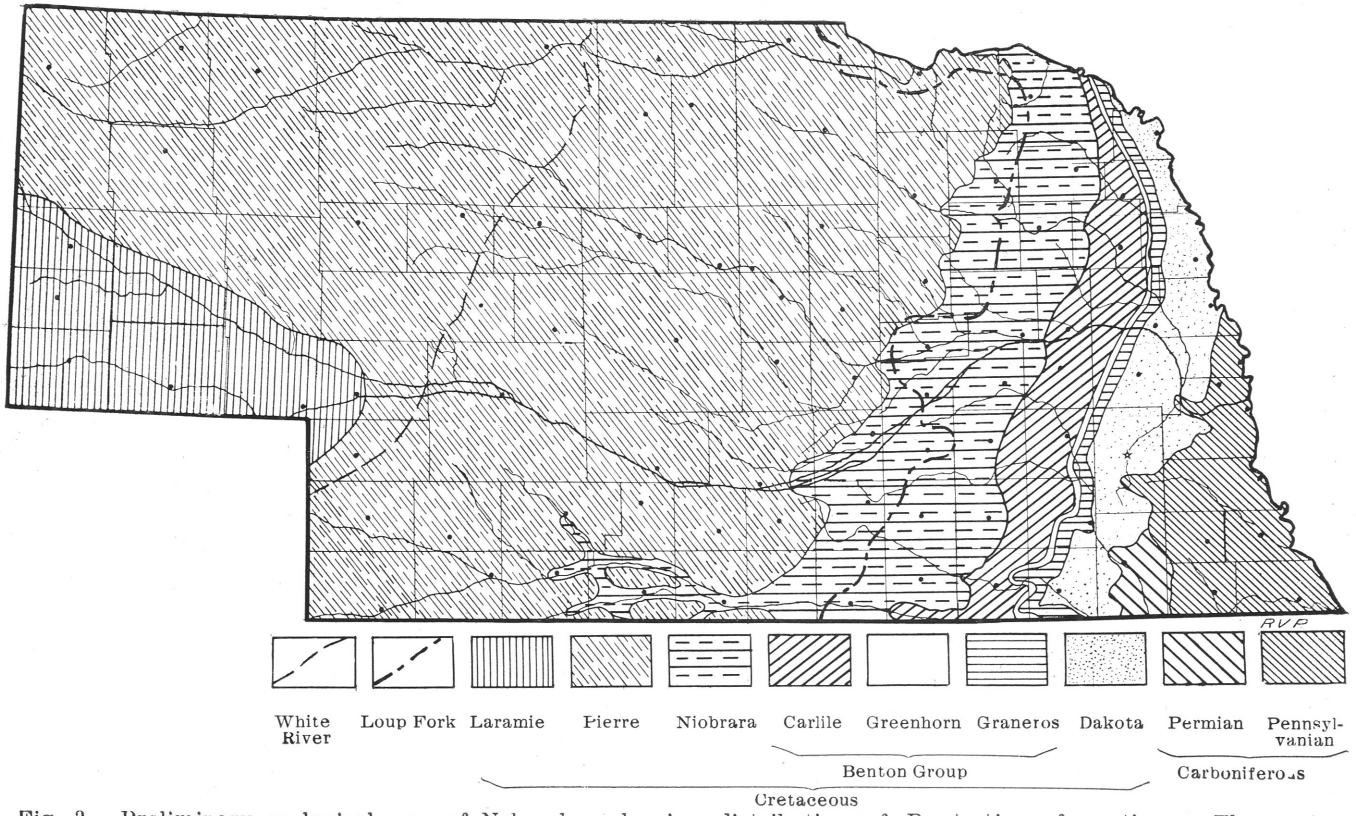

Fig. 2. Preliminary geological map of Nebraska, showing distribution of Pre-tertiary formations. The eastern limits of the Loup Fork and White River respectively, are indicated by dotted lines.

in some particular part of the state, and in no case does his answer, that it is probably not present in paying quantities, stop the coal excited people from spending their money.

The towns that have had repeated coal excitements in the Pennsylvanian section are: Rulo, Humboldt, Tecumseh, Peru, South Fork, Nebraska City, Falls City, and Plattsmouth. Others might be added to this list including most of the towns in the eleven counties above named.

The coal that has been obtained is of fairly good burning quality, but runs high in moisture and ash, and comparatively low in fixed carbon for a bituminous coal. Our coal beds range from four to thirty-six inches in thickness, and in some places are found at a depth of many feet below the surface, making it entirely impracticable to mine.

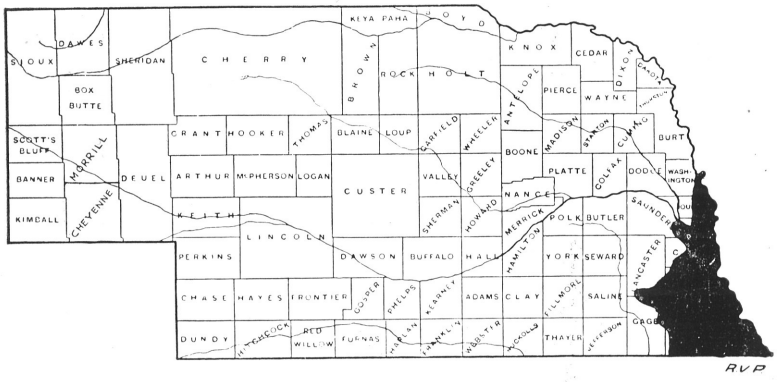

Fig. 3. Exposure of the Pennsylvanian in Nebraska. In the eastern edge of this area the coal bed varies from one foot in thickness to approximately three feet. In the western edge it pinches out to a few inches.

The only coal mine now being operated within the state is the Honey Creek Coal Mine at Peru. In this mine the coal is about thirty-three inches thick, and while it no doubt will prove to be a profitable working bed of coal, its importance is confined to a very small area. Relative to this mine, Professor E. H. Barbour, State Geologist for Nebraska, says,[1] "It has certainly been the opinion of geologists at large that

1. Nebraska Geological Survey, Vol. II, p. 355.

commercial coal of great extent was not to be expected in Nebraska, and the occurrence of a workable bed in Peru does not materially change this opinion, for at best it must be local, being confined to perhaps a township of two, as shown by the surrounding deep wells. Though limited to a square mile or so it is of importance to this commonwealth."

HONEY CREEK COAL MINE.

Discovery and Development.

A coal-like seam had long been observed outcropping along Honey Creek, four miles southeast of Peru, Nebraska. It is said to have been noticed first by Wm. Vandiford some thirty-eight years ago, but was never thought to be of sufficient thickness to warrant mining.

On February 11, 1906, while digging a road, Wm. H. Rader discovered that this coal seam thickened as it extended into the hill. Suspecting that this was a valuable discovery, Mr. Rader reported his observations to Messrs. George and Meadly, who had leased from A. M. Borst the land upon which the outcrop occurred. The curiosity of these men being aroused they commenced digging and tunneling into the hillside that day.

May 1st, 1906, Mr. Medley's interest was purchased by Mr. J. P. Hays and the work progressed under the name of Hays and George until November, 1908, when a company was formed with Mr. J. B. McGrew of Bloomington, Nebraska, as president. It is to be incorporated as the Honey Creek Mining Company, with a paid up capital of $15,000. This company now operates the mine with Mr. Stephen George in charge.

Location and Topography.

The Honey Creek Coal Mine is located two miles south, and two miles east of Peru, in the N. W. quarter, of Section 36, T. 6., R. 15 E., Nemaha County, Nebraska. (See Fig. 4.)

The tunnels No. 1 and No. 2 (See Fig. 7) enter the northwest side of a large hill, the topography of which(See Fig.

5) is observed to be that of a ridge 140 feet high and 2,071 feet long, tapering and pointing toward the north. On the north and west of this hill Honey Creek flows directly past the entrance of the mine and about twelve feet below it. On the east, just at the foot of the hill, is the B. & M. R. R. track at a level of ten feet below that of the mine, and about one hundred yards east of the track is the Missouri River, into which Honey Creek empties.

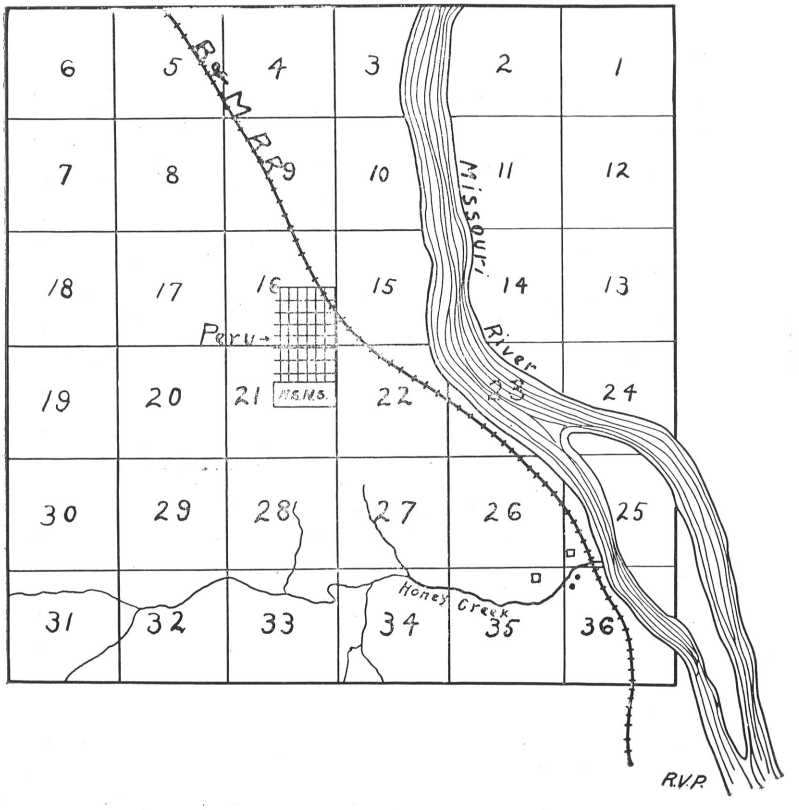

Fig. 4. Map showing the location of the Honey Creek Coal Mine in the northwest corner of Sec. 36. The two dots show the two tunnels.

Extent and Quality of Coal.

The extent of the coal is not definitely known as yet, but it is reasonable to suppose that it at least underlies all of

Honey Creek Hill with approximately the same thickness as in the portions now worked and it is very probable that the coal will be found in adjoining hills, where the same indications may now be observed which led to the development of Honey Creek Coal Mine. The thickness of the coal in neighboring hills is not known; it is not likely that the bed thickens, while it is probable that it pinches out rapidly toward the south and west. Drilling should be done in these hills and the exact thickness and extent of the coal ascertained.

Measurements made throughout the Honey Creek Mine show coal varying from 29¼ to 35½ inches, with an average of 32.9 inches. The following measurements were made by the writer in a very careful manner in April, 1907:

Measurement at No. 1	34 inches
Measurement at No. 2	29¼ inches
Measurement at No. 3	29⅜ inches
Measurement at No. 4	35 inches
Measurement at No. 5	31½ inches
Measurement at No. 6	33½ inches
Measurement at No. 7	31 inches
Measurement at No. 8	33½ inches
Measurement at No. 9	34½ inches
Measurement at No. 10	35⅛ inches
Measurement at No. 11	31¾ inches
[1]Average	32.9 inches

Upon visiting the mine recently the writer was informed that as work progressed the bed of coal had thickened to 36 or 38 inches, but being unable to verify this statement by measurements, on account of the presence of water in the mine, these figures cannot be vouched for.

Taking the thickness at about 33 inches, it will require a little over one square yard to produce a ton of coal. Since there are about 218,418 square yards in Honey Creek Hill, at the coal level, there are about 218,000 tons of coal, providing

1. For places at which measurements were taken see Fig. 9.

the thickness of 33 inches is maintained throughout the hill. In case the coal has now reached a thickness of 38 inches, as is claimed by the operators of the mine, the hill may contain as much as 250,000 tons of coal.

Geology and Stratigraphy.

Although the formations occuring at Peru, Nebraska, have

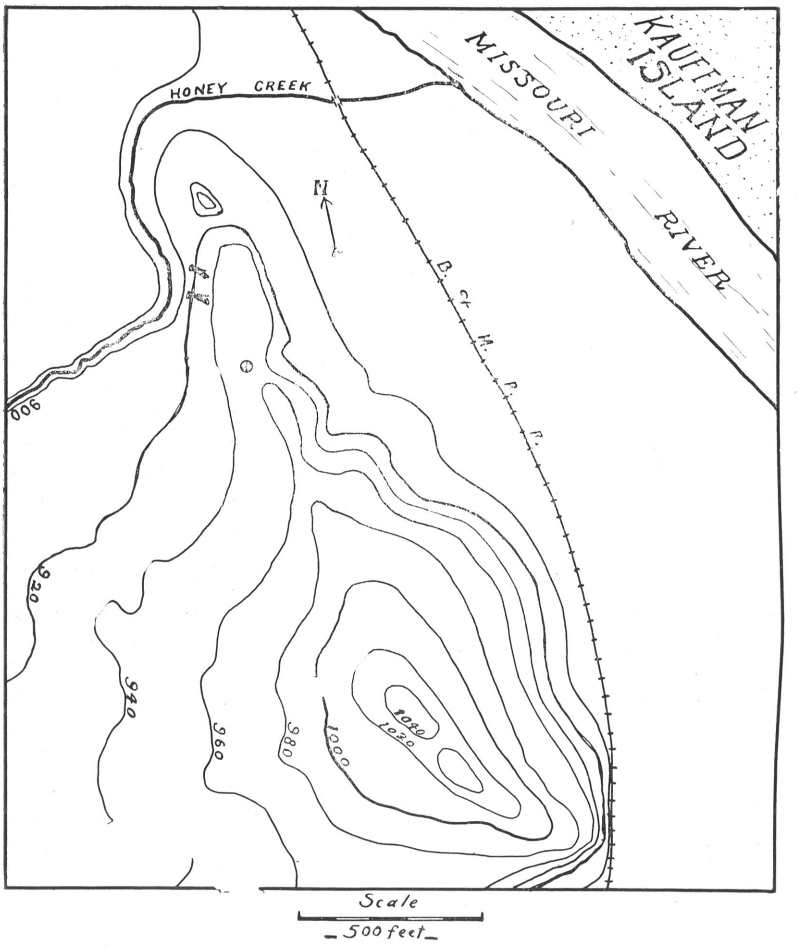

Fig. 5. Topography of Honey Creek Hill, Sec. 36, T. 6, R. 15 E. Peru, Nebraska. Datum Plane mean sea level. Contour interval 20 feet. The two black bars are tunnels; the crossed circle an air shaft.

not been as carefully traced as they should be in order to positively identify them, still, as the result of tracing between Nebraska City and Peru, together with the correlation of these beds by various geologists of the Nebraska, Kansas, Iowa, and United States Geological Surveys, the writer feels justified in pronouncing the formation here as an upper member of the Atchison Shales (Prosser's Waubansee). It is possible that the Carboniferous flora from the vicinity of Peru and Nebraska City recently described by the writer, and soon to be published by the State Survey, may, after its horizon is definitely known, change the position of the beds as now regarded.

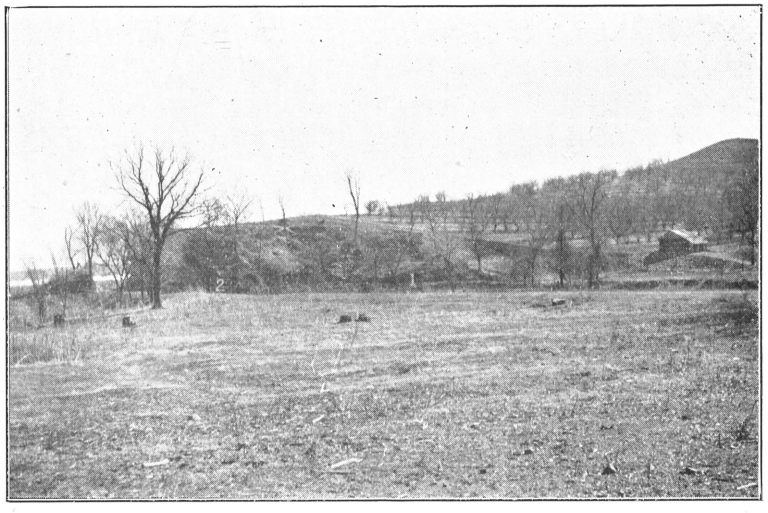

Fig. 6. View looking east from Mr. William Rader's across Honey Creek Valley. To the left through the railroad cut may be seen the Missouri River. Tunnels 1 and 2 are numbered accordingly. At 2 the overlying rock and shale are about 50 feet thick, at 1 about 60 feet, and at the summit of the hill 120 feet. This expanding ridge for a mile or two to the south is known to be underlaid with coal. Compare Fig. 7, Negative No. 2-16-2-07. Hon. Charles H. Morrill's collection of geological photographs, the University of Nebraska.

A section of Honey Creek Hill (See Figs. 7, 8) shows the coal to be overlaid and underlaid by a dark compact shale,

which weathers rapidly on exposure to the air. This latter property is quite evident in the mine where the roofing shale weathers and falls to the floor after being exposed for a few months. It makes, nevertheless, an excellent roofing for the mine. This shale is covered by an uneven layer of Loess varying from 10 to 75 feet in thickness.

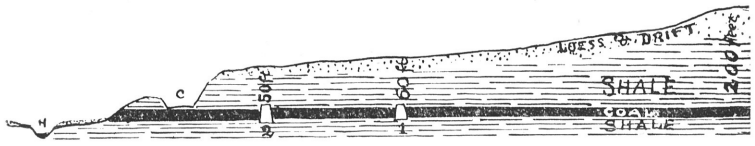

Fig. 7. A geological section running north and south through Honey Creek Coal Mine, showing carboniferous overlaid with Drift and Loess. C—Old railroad cut; H—Honey Creek. Tunnels at 1 and 2.

The general dip of these beds is toward the southwest, but is scarcely noticeable in the small extent of the coal area exposed. There is, however, a small, rather interesting syncline present, which is plainly evident throughout the mine as far as now worked. The trough of this syncline crosses tunnel No. 2 about 50 feet from the entrance, running in a north and west direction. The seepage water from the mine runs into this syncline making what the miners term a "water course" by means of which the water is carried to a "sunk" (See letter S Fig. 9) where the water is about four feet deep, and from which place it is drawn out of the mine by means

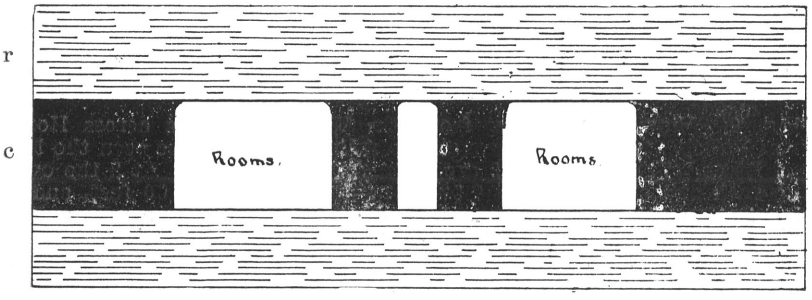

Fig. 8. Sectional view at Honey Creek Coal Mine, tunnel No. 2, showing room and pillar method of mining. t, tunnel No. 2; r, roofiing shale; c, coal bed with a maximum thickness of 35 to 36 inches, a minimum of 29 ¼ inches and an average of 32.9, or 33 inches in round numbers.

of a syphon, which drains into Honey Creek.

Method of Working.

When operation was begun on the mine two tunnels were dug extending about 150 feet into the hill, where the miners started to remove the coal on the plan of the room-and-pillar system. This is done by working the coal from either side of the tunnel in long rooms, leaving a wall or pillar of coal some six feet wide on each side of the tunnel to support the roof, some timbering also being done. During the past year this system of mining was replaced by the long-wall method, in which all of the coal is removed, advancing the face in all directions at the same time in the form of a circle about the tunnel. As the face is advanced the roof is supported by timbers placed along the entries, (Fig. 10) and the waste shale is packed against these props forming what is known as the "gob" or "packed wall." The weight of the overlying strata must be borne by this "gob" and by the time the roof has settled to a permanent position, it has compressed the material in the "gob" from 36 inches to 18 inches in thickness, having settled one half of the distance formerly occupied by the coal, under the immense weight of the overlying shale and Loess.

The coal is removed by hand, with the aid of picks and levers, and is transported from the mine by means of push-cars, which run on light rail tracks, to the dump, where it is emptied on the storage pile, or loaded into wagons to be hauled to town or to the freight cars, which are close at hand.(Fig. 11).

When first operated the mine was ventilated in a very crude manner, but an air shaft has now been sunk through 40 feet of Loess and shale, into the face of tunnel No. 2 at the point marked by a crossed circle (See Fig. 5) and by means of this outlet quite an air current is produced and proper ventilation insured.

Physical and Chemical Properties.

The Peru coal is what would be classed as a fair or medium

grade of bituminous coal. It does not come up to the standard of the average Iowa or Kansas coal but is as good in quality as some coal mined in those states.

It is hard and compact when first mined but soon slacks, crumbling to small pieces on exposure to the air. It is for this reason, a poor coal for shipping or storing, and is best adapted for immediate boiler or domestic use.

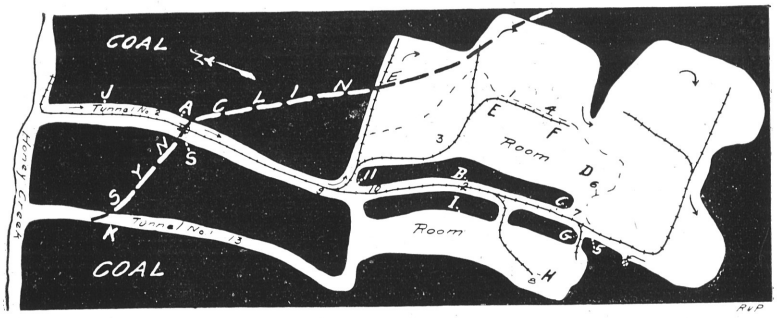

Fig. 9. Ground plan of the Honey Creek Coal Mine. The numbers show where measurements were made see page 285, letters, where coal samples were taken for analysis, see page 292. S. equals "sunk"; the cross circle near 5 indicates the position of the air shaft.

It has a specific gravity of 1.28, burns well, giving a good amount of heat and leaving a soft, red ash of rather large amount for a bituminous coal.

The first chemical analyses of the Peru coal were made in 1906 by L. J. Pepperberg, then a Fellow in the Department of Geology. The record of these analyses is given below: the first of the three samples is air-dried, the second water-soaked as mined, and the third is lignitic coal from Cumberland, Wyoming, for comparison:

			Coke					
No.	Moisture	Volatile Matter	Fixed Carbon	Ash	Total	B. T. U. per Lbs. Coal	Volatile Matter pc. con b.	Fixed C. pc. of Comb.
1	10.	45.25	36.28	8.47	100	12,621	55.50	44.50
2	32.22	28.54	19.38	19.86	100	7,492	54.80	45.20
3	3.65	44.27	46.18	5.90	100	14,100	54.90	45.10

These samples were taken from near the surface and represent weathered coal, which explains the high per cent of moisture and ash. They are placed beside a Cumberland, Wyom-

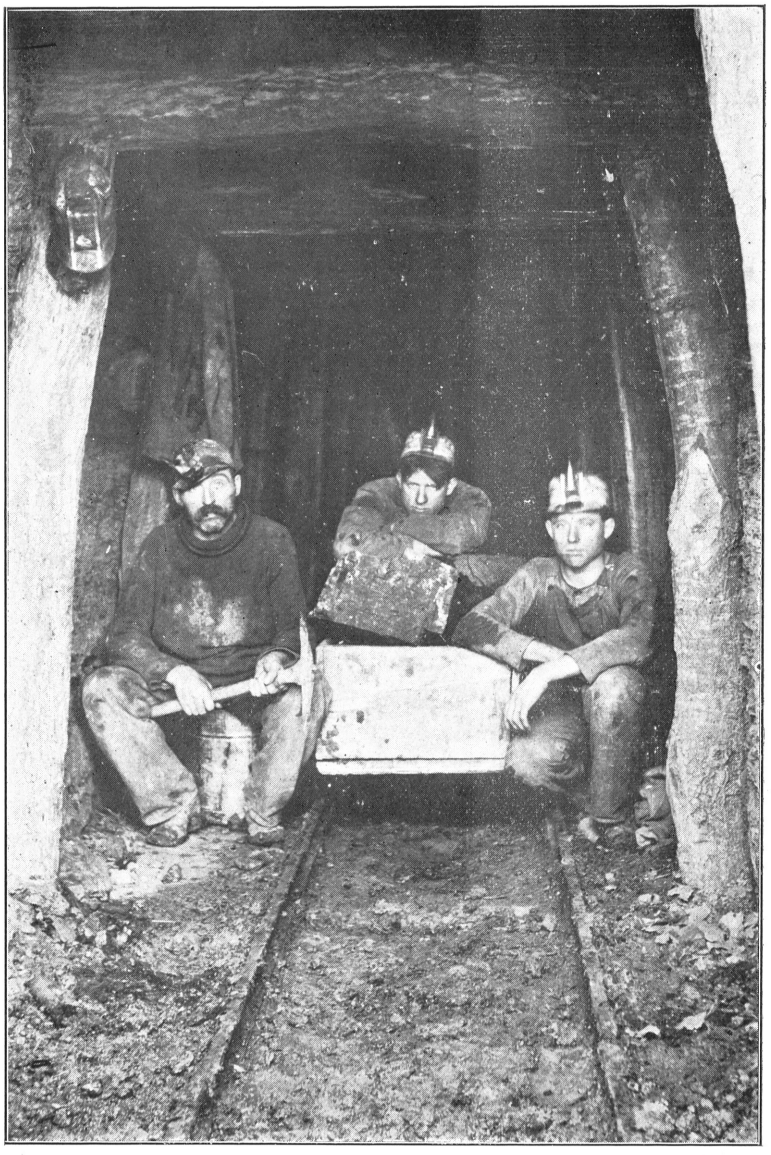

Fig. 10. Honey Creek Coal Mine, tunnel No. 2, showing method of timbering, coal car, track, and three miners. Negative No. 10-16-2-07. Hon. Charles H. Morrill's collection of geological photographs.

ing, coal for comparison, the volatile combustible matter being practically the same per cent of the total combustibles in the two coals.

In April, 1907, eleven samples were taken from various points throughout the mine (Fig. 9, A to K inclusive) and have since been analyzed by the writer, in the laboratory of the Department of Chemistry, where laboratory privileges were freely extended to him while engaged in this work.

The following are analyses run "mine-wet" according to the method approved by the report of the Committee in the American Chemical Society Journal:[1]

No.	Moisture	Volatile Comb. Matter	Fixed Carbon [2]	Ash	Fixed Carbon pc. comb.	Volatile Matter pc. comb.	Sulphur
1	22.5	35.2	31.6	10.7	47.3	52.7	
2	23.3	35.5	31.9	9.3	47.4	52.6	
3	22.1	33.8	32.2	11.9	48.8	51.2	
4	23.5	32.3	30.9	13.3	48.8	51.2	
5	25.2	29.8	37.4	7.6	55.7	44.3	
6	25.7	32.0	33.5	8.8	51.1	48.9	
7	25.9	30.6	35.0	8.4	53.3	46.7	
8	26.3	32.3	34.1	7.3	51.4	48.6	
9	25.1	30.5	34.1	10.3	52.8	47.2	
10	26.4	36.0	29.9	7.7	45.8	54.2	
11	40.2	25.5	23.3	11.0	47.7	52.3	
Av. 1-9	24.4	32.4	33.4	9.7	50.7	49.3	6.22
12	13.42	39.83	39.29	9.46	.....	.....	
13	26.84	32.14	34.19	6.83	.....	.....	
14	28.47	28.63	35.32	7.58	.....	.....	

Samples Nos. 12, 13, and 14 are included for comparison, the first of these being from Blacksmith, Kansas, the other two from sub-bituminous coal of Montana.

The above samples show a decided improvement over the samples taken in 1906, with a marked decrease in the per cent of moisture and ash and a corresponding increase in the per cent of volatile combustible matter and fixed carbon. The per cent of fixed carbon in the coal has shown a decided in-

1. Volume 21, p. 1116-32.

2. The physical quality of the above coal is such that appreciable quantities of carbon were carried off when the fine powder was burned, making the per cent of fixed carbon low.

Fig. 11. The Honey Creek Coal Mine. entrance to tunnel No. 2. One of the proprietors, Mr. Hayes, stands at the right, the other, Mr. George, to the left. A group of miners stand at the entrance. To the right and left is a streak of weathered coal, which leads to a 33-inch bed near the entrance. Negative No. 8-16-2-07. Hon Charles Morrill's collection of geological photographs, the University of Nebraska.

crease and this is the most important factor in determining the value of a coal.

As stated above the coal shows much improvement on going further back into the mine, but after entering some distance the difference as shown by analyses is slight and is purely local, indicating no probable change in the coal throughout the hill from that now obtained, at least in so far as chemical properties are concerned. Physically the coal has a better color, luster, and is harder than the coal first mined.

Value

The value of any coal depends essentially upon its:

1. Chemical contents.
2. Cost of working.
3. Relation to market.
4. Coking properties.
5. Surrounding formations with reference to the possible production of brick, lime, cement,etc.

1. The chemical contents of the Peru coal have been sufficiently discussed above.

2. The cost of working is a very important question in any mine, and under this heading many things might be suggested which affect the cost of mining coal. It is sufficient at this time merely to say that at the Honey Creek Mine labor is not high; the coal having parting planes is not hard to work; the seepage water and ventilation are easily taken care of; wood is at hand to supply such timbering as is necessary; and no shafts have to be sunk, so the coal is taken out on the level of the mine without much labor or expense. However, it should be added that the thickness of the coal is not great enough but that the working-cost per ton will always run high, and especially so since it is mined by hand.

3. The relation of coal to market demands is self-evident, and the conditions at Peru are quite favorable. Since it is not a good shipping coal, the importance of immediate consumption becomes greater.

The Honey Creek Coal Mine has furnished most of the coal

used by the town of Peru and the State Normal School situated there, for the past two years, and carload shipments have been made to Auburn, Brownville, Nemaha City, Orleans, and Republican City.

4. The Honey Creek coal is not a good coking coal.

5. The overlying and underlying shales suggest the manufacture of brick and various clay wares, and the burning of "gumbo" for railroad ballast.

The writer has seen no limestone in the vicinity, which might prove suitable for the manufacture of Portland cement and which might add to the immediate uses and consequently increase the value of the coal.

The actual value of the Honey Creek coal on the market is $3.50 per ton at the mine. Thus taking the figures as given above, namely that a 33 inch bed throughout the hill contains about 218,000 tons, a value of $763,000.00 may be set on the Honey Creek coal, or in case the bed thickens so as to contain 250,000 tons, the value would be about $875,000.00. These estimates are necessarily but approximations.

According to the terms of the original lease a royalty of fifty cents per ton was paid to the lessor on all coal selling for three dollars a ton, and one dollar for coal selling for four dollars. The royalty has now been reduced from fifty to twenty-five cents per ton, so that when the entire hill is worked, if the above figures are correct and the present royalty maintained, the lessor will have received between $54,500.00 and $62,500.00 as royalty from the coal removed.

Output.

The output of the Honey Creek Coal Mine up to date is as follows:

Feb. 11, 1906, to Aug. 31, 1906 Approx.....	75 T	$ 262.00
September, 1906, coal marketed.....	20 T	70.00
October, 1906, coal marketed.....	25 T	87.00
November, 1906, coal marketed.....	50 T	175.00
December, 1906, coal marketed.....	70 T	245.00
Total for 1906.....	200 T	$ 839.00

January, 1907, coal marketed	85 T	$298.00
February 1 to 15, 1907, coal marketed	75 T	262.00
February 15 to 28, 1907, coal marketed	114 T	399.00
September, 1907, coal marketed	63 T	220.00
October, 1907, coal marketed	96 T	336.00
November, 1907, coal marketed	138 T	483.00
December, 1907, coal marketed	75 T	262.00
Total for 1907	646 T	$2,260.00
January, 1908, coal marketed	43 T	150.50
February, 1908, coal marketed	38 T	133.00
March, 1908, coal marketed	60 T	210.00
Closed on account of fire and subsequent flooding until Nov. 1908.		
December, 1908, coal marketed	20 T	70.00
Total for 1908	161 T	$563.50
January, 1909, coal marketed	30 T	105.00
February, 1909, coal marketed	30 T	105.00
Owing to a series of fires and cave-ins tunnels No. 1 and No. 2 have been abandoned for several months, but a new tunnel is under construction.		
September, 1909, coal marketed	9 T	38.25
October, 1909, coal marketed	32 T	136.00
Total for 1909	111 T	$ 384.25
Grand total	1,118 T	$4,046.75

A new company has been formed and mining operations are to be resumed in the summer or fall of 1910.

Dakota Formation.

The outcrops of this formation are shown by Figures 1, and 2 to occur in Jefferson, Gage, Lancaster, Cass, Saunders, Sarpy, Douglas, Dodge, Washington, Burt, Thurston and Dakota counties. The formation is between three hundred and four hundred feet thick and like all other formations here discussed extends under the entire state west of the line of outcrop. (Fig. 2.)

Thin seams of lignite occur in the Dakota and have caused nearly as much excitement and loss of money as the coal seams in the Pennsylvanian. It has been worked somewhat at Ponca, Dixon County; (possibly Graneros, compare page 298) Valparaiso, Saunders County; Homer, Dakota County, and has been reached by drilling at two levels at Jackson, Dakota County; in Cedar County; at Jamestown, Dodge County; and along the Big Blue River near Milford and Crete. The lignite at these places varies from six inches to two feet in thickness and is only of fair grade, running high in moisture and ash and weathering rapidly on exposure to the air. Four analyses of Dakota County-coal by E. F. Burchard occur below.

Samples No. 1 and No. 2 and No. 3 were obtained by drilling three miles north of Jackson and were air-dried; sample No. 4 is from Homer, partly air-dried:

No.	Moisture	Vol. Matter	Fixed carbon	Ash	Sulphur	Total
1	4.99	41.63	27.14	25.72	1.22	100.70
2	4.03	51.40	33.66	10.91	....	100.00
3	6.50	28.00	49.30	16.20	....	100.00
4	17.85	44.27	26.00	10.91	1.14	100.17

The largest production of this coal in one year was in 1897 when 550 tons were mined in Dixon County, selling for $1,500.00.

As to working these lignite beds, Professor J. E. Todd, acting as State Geologist for South Dakota[1] said, "In my judgment it is absolutely useless for people to spend money in southeastern South Dakota, southwestern Minnesota, northwestern Iowa, or northeastern Nebraska for the purpose of hunting for coal or in the work of developing such isolated finds as occasionally may be struck; because there isn't any large body of coal, lignite or otherwise and if there were such deposits they could not be worked owing to the absence of a substantial covering and the presence of overwhelming subterranean floods of water."

A bed of lignite seven inches thick (possibly Graneros,) was worked in 1903 at Powell, Jefferson County, along the

1. Newspaper clipping, Department of Geology. (Date and name of paper unknown).

Little Blue River, and thin beds similar to this one may be found throughout the Dakota region. Lignite beds are worked in Jewel County, Kansas, and there is a possibility that the same beds may be found in the vicinity of Superior, Nebraska, of sufficient thickness to work profitably if not found too deeply covered with later deposits.

Graneros Formation.

The outcrop of the Graneros is poorly defined, but occupies a narrow strip (Fig. 2) extending through Thayer, Jefferson, Saline, Seward, Lancaster, Saunders, Dodge, Burt, Thurston, Dakota, and Dixon Counties. It varies from forty to sixty feet in thickness in eastern Nebraska and is 800 or 900 feet thick in the Black Hills.

The only coal in this formation is found near its base and has been worked at Ponca, Dixon County. These are the same seams spoken of in the Dakota formation and there is a difference of opinion as to which of these formations the coal belongs. It makes little difference, however, except from a scientific standpoint.

Throughout various parts of this region dark colored shales are found at the base of the Graneros and are invariably taken for coal or indications of coal, by the well diggers and drillers and property owners. No important beds of coal are to be expected in this formation, and at such places where prospecting has been extensively done, as in Dixon and Jefferson Counties, it has been entirely without success.

Near Hubbel, Thayer County, occurs a dark carbonaceous shale, seven feet thick, which has been mistaken for coal many times and has caused much excitement in that vicinity. It will not burn nor is it even an indication that coal is present, and people living in this section should become familiar with this shale so as to avoid such expensive mistakes in the future as have been made during past years.

Pierre Shale Formation.

The Pierre Shale overlies the Niobrara and outcrops south of the Missouri River in Knox and Cedar Counties, along the

Niobrara River in Holt, Boyd, Rock, and Brown Counties, along the Republican Valley from Republican City to Arapahoe and from McCook to the Colorado line and along Pine Ridge in the northern part of Sheridan, Dawes and Sioux counties west of the Wyoming line. From east to west it increases in thickness up to two or three thousand feet or more. (Fig. 1).

As exposed along the Missouri River between Chamberlain, South Dakota, and Cedar County, Nebraska[1] and along the Republican River between Republican City and Oxford, the base of this formation contains a carbonaceous streak 10 to 30 feet thick which stands out in strong contrast to the underlying Niobrara chalk-rock and like the dark-colored shale in the Graneros, has often been prospected for coal. Near Orleans, Harlan County, much prospecting is done in this shale, the farmers thinking that as they dig back into the hillside the shale will be replaced by coal. This is not the case, however, and prospecting here is absolutely useless.

Laramie Formation.

The Laramie, a coal-bearing formation of Colorado and Wyoming, overlies the Pierre shale formation and is the top member of the exposed Cretaceous in Nebraska. It is thought to underlie a part of Banner, Kimball and the southern part of Cheyenne Counties. The only outcrop known in Nebraska is in Scotts Bluff County,[2] near the Wyoming line. It is barely possible that Laramie coal may extend into western Nebraska. It almost surrounds western Nebraska, for it outcrops extensively in North Dakota, Montana, Wyoming, and Colorado, in which states it carries considerable amounts of coal.

The Laramie coal is a lignite and occurs near the base of the formation in several beds, four to fourteen feet thick in all, and can be worked profitably where it occurs at the surface, but as the outcrop is followed back it dips to such a great depth that it cannot be worked to advantage.

1. Traced by Dr. G. E. Condra.
2. Reported by C. A. Fisher.

Conclusion.

In conclusion it may be said that Nebraska lies on the western border of the Carboniferous coal basin and on the eastern border of the Cretaceous field, and while thin beds of coal occur in these formations, it is not to be expected that much coal will ever be found in this State.

Fruitless prospecting has already shown this to be true in the Pennsylvanian region of the southeastern counties as stated above. The same is true of the Dakota area, and it should be emphasized that if thick beds of coal were present, which is probably not the case, but at some distance below the surface, the presence of seepage water and of artesian water would make it impracticable to mine the coal.

We should even discourage prospecting for coal in all Cretaceous formations except the Laramie, in which it is possible, though not probable, that workable beds of coal will be found.

In short then, however much it is desired, hoped, and believed that beds of coal occur in Nebraska in sufficient thickness to supply the needs of this commonwealth, from present knowledge they probably do not exist.

COAL IN THE UNITED STATES.

Coal is by far the most important mineral product of the world. It is the only fuel used universally, and is the one of greatest commercial importance.

The value of the leading mineral products of the United States for 1907, were:[1]

Coal	$614,798,898
Iron	529,958,000
Clay products	158,942,369
Copper	173,799,300
Oil and gas	174,329,148
Gold and silver	127,735,400

The above table shows coal to be of greater commercial value in the United States than gold, silver, copper, oil and gas combined. This is not true, however, in all countries,

1. U. S. G. S. "Mineral Resources." 1907.

for the United States is the leading nation in the production of coal. In 1907 the four leading nations were:

United States, producing.....480,363,424 short tons
Great Britain, producing.....299,970,677 short tons
Germany, producing.....226,773,605 short tons
Austria-Hungary, producing..... 43,955,315 short tons

The other nations follow with much smaller productions, the output of the United States being 39.70 per cent of the entire output of the world.

The increase in the consumption of coal has been astonishingly rapid. In the United States the consumption has increased over three-fold in the past twenty years, and nearly seven-fold in the past thirty years.

Mr. M. R. Campbell (United States Geological Survey) has estimated[1] that at the present rate of consumption the coal reserves of the United States will last approximately four thousand years, "but if the constantly increasing rate, which has marked the consumption during the past ninety years, be maintained, our coal will practically be exhausted within one hundred years."

Figure 12 shows the output of coal in 1906 in the leading coal producing states of the United States together with the approximate number of square miles of coal in the state.

Distribution.

Figure 13 shows the distribution of coal in the United States. There are five principal regions, as follows in the order of their importance:[2]

APPROXIMATE AREA OF AMERICAN COAL.

	[1]Region	Area in Sq. Mi.	Production in 1906	Pc. of total Bitm's
Carboniferous coal	Appalachian	70,807	233,473,524 short tons	68.1
	Central	58,000	59,457,660 short tons	17.34
	Western	94,076	23,086,348 short tons	6.73
	Michigan	11,000	.....	.....
	Rhode Island	500	.....	.....
Cretaceous coal	Rocky Mts.	100,000	22,064,003 short tons	6.44
	Pacific Coast	1,050	3,386,745 short tons	.....

1. National Geographical Magazine, Feb., 1907, p. 138.
2. U. S. G. C. "Mineral Resources," 1906, p. 586.

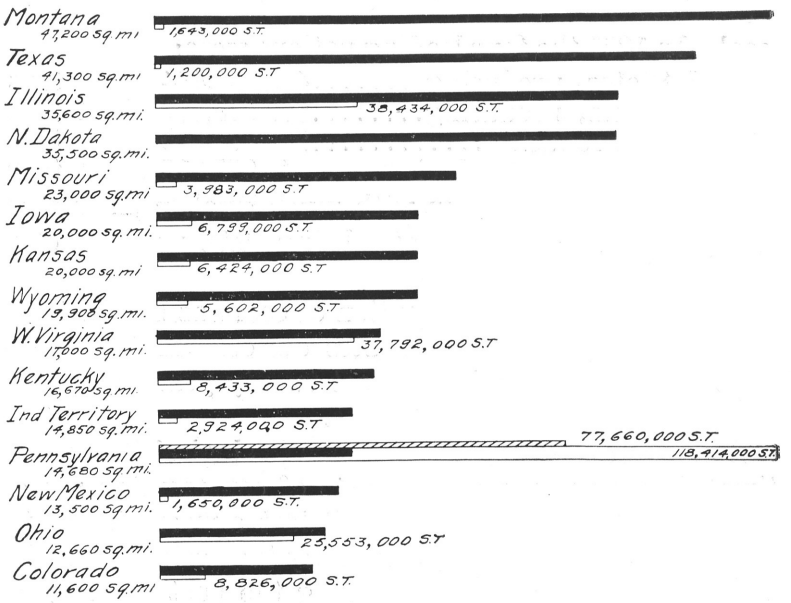

Fig. 12. Coal areas and output by states, 1906. Black lines equal area of coal fields. White space, followed by figures, show the short tons (S. T.) mined. The lined area of Pennsylvania, equals anthracite. Modified after U. S. Geol. Survey.

Kinds of Coal.

Coal may be classified in two different ways, as to its purity and as to the amount of fixed carbon it contains.

Under the first classification we have:

1. Pure Coal—low in ash.
2. Poor coal—high in ash.
3. Shaly coal—very high in ash.
4. Coaly shale—not much coal.
5. Black or carbonaceous shale—just enough coal to give it a black color.

Under the second classification comes a series of coals which are considered as different stages in the evolution of coal from vegetable matter by the processes of time, pressure and the loss of hydrogen and oxygen.

STAGES IN THE COAL SERIES.

1. Peat.
2. Lignite.
3. Sub-bituminous.
4. Semi-bituminous.
5. Bituminous.
6. Semi-anthracite.
7. Anthracite.
8. Graphitic-anthracite.
9. Graphite.

The principal difference in these coals is the varying proportion of:

1. Fixed carbon.
2. Volatile combustible matter.
3. Ash.

Which together with the moisture and sulphur present, total 100 per cent in any coal.

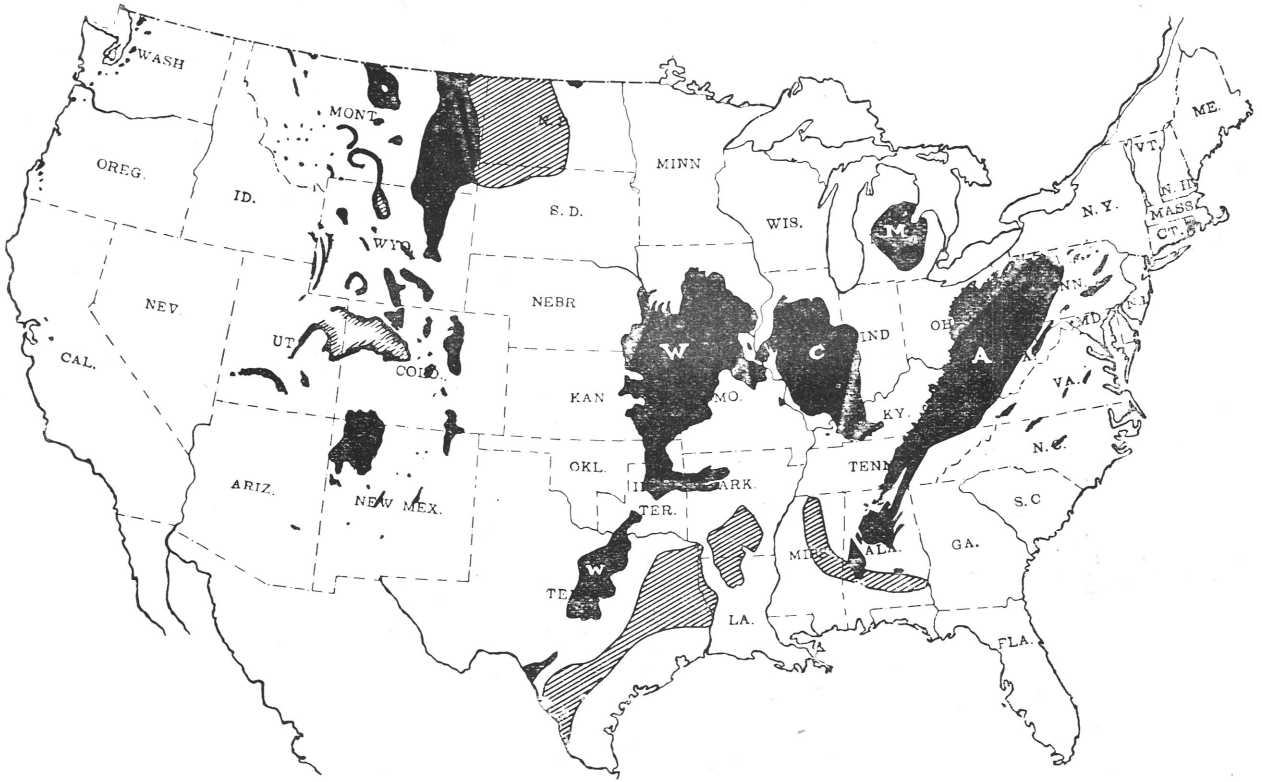

Fig. 13. A coal map of the United States. The coal east of Nebraska is of Carboniferous age; west of Nebraska the coal is of Cretaceous age. A, Appalachian coal field; C, Central coal field; W, Western coal field; M, Michigan coal fiel d; Rhode Island coal field. Ruled area, lignite. Modified after maps of U. S. G. S.

LAW RELATING TO A BOUNTY FOR THE DISCOVERY OF COAL.

(Chapter 58, Compiled Statutes of Nebraska, for 1905.)

Section 1. (Award for discovery of coal or iron.) That when it shall be made apparent to the Governor of Nebraska, by affidavit or otherwise, by the owner or owners thereof, that a vein of coal not less than twenty-six inches in thickness and of sufficient capacity to pay to mine, and within such distance from the surface that it can be worked by modern methods, has been discovered, or vein or veins of good iron ore eighteen inches thick, it shall be the duty of the Governor to appoint a suitable person to examine the same, whose duty it shall be to report the probable extent and capacity of the vein or veins, all expense for said examination to be paid by the owner or owners of said mine. Said report being satisfactory to the Governor, he shall direct the Auditor to draw an order on the Treasurer for the sum of four thousand dollars, to be paid to the owner or owners of said mine of coal, and of two thousand dollars, to be paid for a vein of iron ore eighteen inches thick. If the vein of coal discovered should be three feet thick and of a required capacity, the sum to be paid shall be five thousand dollars. Said orders to be paid out of the general fund of the State treasury as before provided.

Section 4. (Specimen of strata preserved.) It shall be the duty of the persons prospecting for coal, iron ore, crude oil, and gas, carefully to preserve specimens from each stratum through which the shafts are sunk, or borings made, and if the bonus is obtained upon the conditions heretofore mentioned in this bill, to deposit the same properly labeled, in care of the department of the state for the future use of the commonwealth.

Section 5. (Extent of Act.) The provisions of this Act shall not apply to any veins of coal or iron ore already discovered, nor to any oil wells or gas wells already producing, nor shall the provisions of this Act apply to the discovery of the same vein of coal or iron ore, or oil pool or gas field already

discovered, nor shall any award specified under the terms of this Act be paid for a second discovery of the same veins, pools, or fields within the limit of the same county.

Section 6. (Appropriations.) There shall be appropriated out of the funds of the State Treasury for the purpose of this Act, not already appropriated, the sum of twenty-five thousand dollars.

The appropriation carried with the above having lapsed, the following bill was introduced into the thirtieth session of the Nebraska Legislature to cover the Peru coal discovery:

House Roll No. 345—A Bill.

For an act to appropriate the sum of ten thousand dollars ($10,000) for the purpose of encouraging the opening and development of coal and other minerals in the State of Nebraska, and to provide for the expenditure thereof in accordance with the provisions of section 7350, Cobbey's Annotated Statutes of Nebraska.

INTRODUCED BY W. D. REDMOND.

Introduced and read the first time Feb. 14, 1907. Read the second time Feb. 15, 1907, and referred to the Committee on Finance, Ways and Means.

Be it enacted by the Legislature of the State of Nebraska:

Section 1. That the sum of ten thousand dollars ($10,000) or so much thereof as may be necessary be and the same is hereby appropriated out of any money in the general fund of the State not otherwise appropriated for the purpose of encouraging the opening and development of coal and other mineral interests in the State of Nebraska in accordance with the provision of section 7350 of Cobbey's Annotated Statutes of the State of Nebraska.

Section 2. The money appropriated by this act shall be paid by the State Treasurer upon the warrant of the Auditor of Public Accounts issued under the direction of the Governor of the State of Nebraska as provided by law.

Section 3. Whereas an emergency exists this act shall take effect and be in force from and after its passage and approval.

The above bill was reported favorably by the committee and had its third reading and was passed by the House March 27, 1907, by a vote of 68 to 17.

The above bill took a like course in the Senate and was recommended "indefinitely postponed" by the committee. This report was accepted March 30, 1907.

A Bill—House Roll No. 482.

Identical with the above, but carrying an appropriation for four thousand dollars instead of ten thousand dollars, was brought before the thirty-first session of the Legislature of Nebraska by Fred Hector, but before action was taken upon this bill the Claims Committee allowed four thousand dollars on the claim of A. M. Borst of Peru, Neb., which made the passage of House Roll No. 482 unnecessary, as it was intended to cover this particular claim.

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